WIRELESS ACCESS NETWORK USING RADIO OVER FIBER TECHNOLOGY

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Specially..

To my beloved parents and husband

To my kind brothers and sisters

And not forgetting to all friends

For their

Love, Sacrifice, Encouragements, and Best Wishes

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ABSTRACT

A Fiber to the Home (FTTH) transport system based on Radio over Fiber (RoF) is proposed for a cost effective access network as cost remains an important issue in this type of network. Furthermore the installation process gives dissatisfaction among end user which house need to be drilled in other to pull the fiber inside the house. Traditional FTTH is to pull the fiber into the end user's house in other to give better performance and high speed. Obviously, this approach will increase complexity and cost. By using Radio over Fiber (RoF), system complexity and cost is greatly reduced at still give high performance and better quality. Nevertheless, this project shows that the quality is still adequate for access network in high speed. Wireless bridge source is modulated using 5.8 GHz data from the Central Base Station (CBS) and provide high speed between fiber drop points.

ABSTRAK

Sistem penggunaan jalur lebar *Fiber to the Home (FTTH)* dengan menggunakan Rangkaian tanpa wayar berdasarkan teknologi radio and gentian *(RoF)* telah dicadangkan yang menjanjikan penyelesaian berkesan kepada kos untuk memenuhi pertambahan jalur lebar pengguna dan permintaan terhadap tanpa wayar. Tambahan lagi, isu pemasangan yang menyebabkan pengguna tidak berpuas hati kerana rumah perlu di tebuk untuk pemasangan fiber ke dalam rumah. Pada masa kini, perkhidmatan jalur lebar akan di tarik ke dalam kediaman untuk memberikan kualiti dan kelajuan yang di inginkan. Secara keseluruhannya, ini boleh melibatkan pemasangan yang kompleks serta kos yang sangat tinggi. Dengan penggunaan rangkaian tanpa wayar berdasarkan teknologi radio atas gentian (RoF), pemasangan yang kompleks serta kos yang tinggi dapat di kurangkan di samping menjamin kualiti kelajuan. Tambahan lagi, projek ini membuktikan walaupun dengan menggunakan rangkaian tanpa wayar berdasarkan teknologi radio atas gentian (RoF) tetap memberikan kelajuan yang berkualiti. Rangkaian tanpa wayar ini beroperasi menggunakan 5.8 GHz frekuensi bermula daripada *Central Base Station (CBS)* dan akan memberikan kelajuan di antara jalur lebar dan kediaman.

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LIST OF ABBREVIATIONS

FTTH	-	Fiber to the Home
RoF	-	Radio over Fiber
RF	-	Radio Frequency
PON	-	Passive Optical Network
OLTs	-	Optical Line Terminals
ONU	-	Optical Network Unit
ONT	-	Optical Network Terminal
CBS	-	Central Base Station
QAM	-	Quadrature Modulation Amplifier
OFDM	-	Orthogonal Frequency Division Multiplexing
ISI	-	Intersymbol Interference
SMF	-	Single Mode Fiber
WLAN	-	Wireless Local Area Network
ISM	-	Industrial, Scientific and Medical
FCC	-	Federal Communication Commission
MIMO	-	Multiple Input Multiple Output
SISO	-	Single Input Single Output
ONU	-	Optical Network Unit
DP	-	Distribution Point
WDM	-	Wavelength Division Multiplexing
FFT	-	Fast Fourier Transform

LIST OF SYMBOLS

f	-	Frequency
Ghz	-	Gigahertz
Hz	-	Hertz
km	-	Kilometer
M	-	Mega

CHAPTER 1

INTRODUCTION

1.1 Project Background

Fiber to the home (FTTH) is a form of fiber optic communication delivery that reaches one living or working space. The fiber extends from the central base station to the subscriber's living. As the broadband revolution continues, the ever increasing competition in the broadband service market is forcing broadband service supplier to plan the strategies for delivery of 'triple play' services with voice, data and video provided by a single connection. There are lots of competitors are competing technologies which are providing the bandwidth required to deliver broadband services, but each technology needs to consider on its limits bandwidth, reliability, cost or coverage. Optical fiber nowadays offers almost limitless bandwidth capabilities and excellent reliability.

Radio over Fiber (RoF) is a technology where, light is modulated in Radio Frequency (RF) and transmitted over optical fiber to facilitate wireless access. In this project is show that the RF is transmitted using point to point concept at 5.8 GHz. The frequency is chosen because it is an unlicensed band and affords to give high and better quality of service to end user. RoF is a technology which microwave (electrical) signals are distributed by means of optical components and techniques. In order to reduce the system the cost, RoF technology has been proposed since it provides functionally simple

base station to fiber drop point that are interconnected to switching center or otherwise known as central base station (CBS) via an optical fiber. In this project, the fiber drop point is give wireless transmission to end user so that no fiber needed to install inside end user's house.

Nowadays, complexity of installation, cost of deployment, and constrain on transmission distance are some of the problems surrounding the transmission and process installation FTTH. In new concept of wireless architecture using this technology, all the signal processing associated with the base station, usually found in the Optical Line Transmission (OLT), can now be moved to the Central Base Station and the fiber is pulling to the fiber drop point. In this project, fiber drop point containing Multiple Input Multiple Output (MIMO) antenna that gives high bit rate. The antenna is simulating using CST to give the antenna parameter so that is can be extract in the OptiSystem to complete the design. In the OptiSystem design, there was no block for antenna design. The parameter is from S2P parameter files that the important view or this project is to consider the gain and return loss of the antenna. Consequently, the fiber drop point becomes a small module that only consists of a photodetector (PD), and an antenna. In practice, some loss of simplicity may need to be traded for increased range. It will give baseband signal on the fiber drop point. In this project the modulation of Orthogonal Frequency Division Multiplexing (OFDM) is used so that is will give high data rate to the end user. OFDM is a good modulation that can eliminate Intersymbol Inference (ISI) and redundant signal is show in Figure 1.1. The wireless standard also needs to consider giving the high bit rate or speed which is in the project is using 802.11n standards. The benefits of such a system result directly from the shift of complexity away from the fiber drop point unit to end user. In other words, fiber drop point can be used to aid simplification.

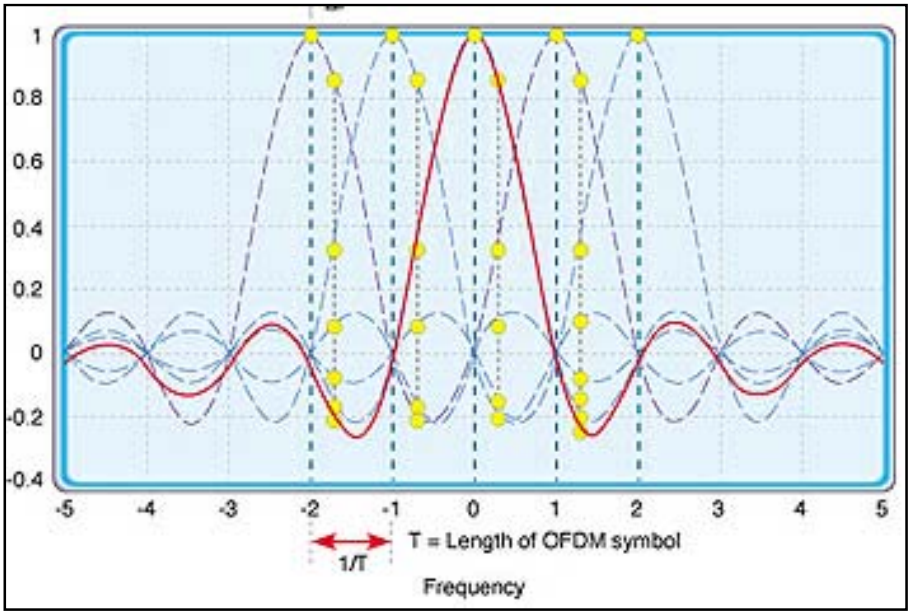

Figure 1.1: OFDM overcome the ISI symbol [1]

1.2 Problem Statements

As in current technology FTTH in Malaysia, there are dissatisfied on end user's point of view, on the installation of fiber outside and inside the house from fiber drop point. Furthermore, the user's house need to be drilled during the installation process of the fiber and time taken is within 4 to 8 hours. The internet service providers also have the dissatisfaction problem too which currently have to pay in expensive way for the installation due to each premise requires differing length of drop fiber and need to manage slack due to non standard length requirements. It may cause complexity of the installation process.

1.3 Objective

The objective of this project is to design and simulate wireless access network using Radio over Fiber technology to improve current FTTH deployment. Furthermore, by improving the current FTTH technology, this project aims to give high bit rate or

speed by maintaining the quality of the service. It also aims of using less fiber optic that can minimize the cost and complexity during the installation. In other word, current FTTH deployment is using lots of fiber optic that may cause expensive and complexity process. Also to give satisfaction to end user that no drilling in the house but still gives better quality of speed which can maintain current FTTH deployment and cover the application given for voice, video and data.

1.4 Scopes of work

In order to achieve the objective of this project, there are following scopes will be covered:

i) To study the concept of the RoF technology and FTTH.

ii) It focuses to simulate high speed connectivity between fiber drop points.

iii) Operating at 5.8 GHz band starting point at Central Base Station (CBS).

iv) OptiSystem software is used to perform the overall design.

1.5 Project Report Outline

This is written to bring the reader step by step going in the main core of the content Chapter 1 provides the introduction to this project where brief background of the study problem and to the statement of the problem and followed by the objective, and the scope of the study.

Chapter 2 covers literature review which an overview of RoF technology which including the concepts, benefits, limitations and applications. It will also cover FTTH concept and the modulation techniques.

Chapter 3 discusses about research methodology of the RoF and overall design specification. Also explains the process of the whole project especially fiber drop point

design and describes the methodological processes by showing detailed diagram of the methods implemented as well as highlighting briefly the steps those need to be followed to achieve the objective of this project.

Chapter 4 shows the results and discussion of the simulation design using OptiSystem and summarized the work that has been done.

Chapter 5 discusses on the conclusion of the project and the future works in other to improve the development of the project.

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